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SWEPT-EXCITED AMPLIFIERS AND FLUCTUATIONS AND CORRELATIONS IN C--ETC(U)
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LEVEL II 12

Prof. F. BONIFACIO

FINAL REPORT

After the last report, our research proceeded on the following main lines:

I) Optical Bistability

II) Cooperative Effects in Josephson Junctions

III) Transverse Effects in Superfluorescence

IV) Free Electron Lasers

I) OPTICAL BISTABILITY [2,3,4,5,6,7,9,10,11,13,15,16,17,18,20,21]

We developed from first principle a complete semiclassical and quantum theory with the following original accomplishments:

i) analytical proof of existence and description of the hysteresis cycle.

ii) first analytical description of the transient behaviour and prevision of new effects.

iii) first quantum theory of the spectrum of the transmitted light together with the forecasting of new non observed effects.

iv) first analytical description of propagation effects with the prevision of an instability of the hysteresis cycle. This fact can be of practical importance since proves the possibility of transforming a cw laser light into a series of short pulses via a passive medium theoretically.

Experiments on our premises are now proceeding in various laboratories, in particular at Max Planck Institute (Prof. H Walther)

II) COOPERATIVE EFFECTS IN JOSEPHSON-JUNCTIONS [14,22]

Extending the theoretical model of Rogovin and Scully we have predicted new transient and stationary effects also in collaboration with the above mentioned authors.

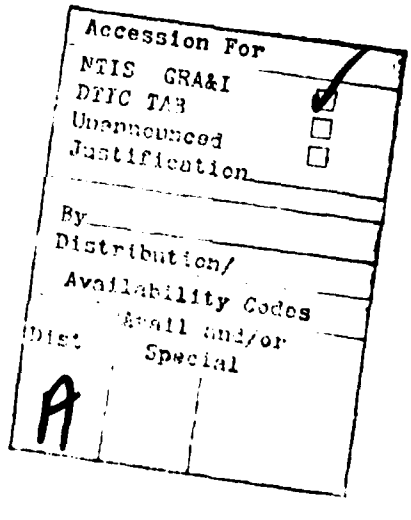
III) TRANSVERSE EFFECTS IN SUPERFLUORESCENCE. [1,8,19]

In collaboration with Narducci and Farina at Drexel University we extended our previous mean field model to take into account transverse ("off-axis") emission. This extension largely improves the agreement between the previous theory and experiments mainly as far as ringing and pulse fluctuations are concerned. These results were also presented at the International Q.E. Conference in Boston 1980

IV) FREE ELECTRON LASER (FEL) [23,24,25,26,27,28]

In collaboration with the Scully group we have given a general theory of gain-spread properties of a FEL. This theory refers to a low density system in which many-particle cooperative effects can be neglected as they are in all existing theories to our Knowledge.

In the last year we intensively studied high density collective effects reaching recently very interesting results (unpublished) concerning the possibility of chaotic high intensity superradiant spiking behaviour of a FEL.



1 R. Bonifacio, M.Gronchi, L.A.Lugiato and A.M.Ricca, "Maxwell-Bloch Equations and Mean Field Theory for Superfluorescence" in "Cooperative Effects in Matter and Radiation", ed.by C.M.Bowden, D.W.Howgate and H.R.Robl (Plenum, N.Y. 1977) pg. 193.

2 R.Bonifacio and L.A.Lugiato, "Optical Bistability and Cooperative Effects in Resonance Fluorescence", Phys.Rev. A 18, (1978) 1129.

3 R.Bonifacio and L.A.Lugiato, "Bistable Absorption in a Ring Cavity", Lett. Nuovo Cimento 21, 505 (1978)

4 R.Bonifacio and L.A.Lugiato, "Photon Statistics and Spectrum of Transmitted Light in Optical Bistability" Phys.Rev. Lett. 40, 1023 (1978).

5 R.Bonifacio and L.A.Lugiato, "Mean Field Model for Absorptive and Dispersive bistability with Inhomogeneous Broadening". Lett. Nuovo Cimento 21, 517 (1978).

6 R.Bonifacio and L.A.Lugiato, "Instabilities for a Coherently Driven Absorber in a Ring Cavity". Lett. Nuovo Cimento 21, 510 (1978).

7 R.Bonifacio and L.A.Lugiato, "Cooperative Effects in Optical Bistability and Resonance Fluorescence". Proceedings of IV Rochester Conference on Coherence and Quantum Optics - June 8 to 10, 1977 (Invited Paper).

8 R.Bonifacio, M.Gronchi, L.A.Lugiato and A.M.Ricca, "Superfluorescence: Maxwell-Bloch Equations, Mean-Field Approach and CS Experiment. Proceedinhs of IV Rochester Conference on Coherence and Quantum Optics - June 8 to 10, 1977.

9 R.Bonifacio, M.Gronchi and L.A.Lugiato: "Photon Statistics of a Bistable Absorber" - Phys.Rev. A 18, 2266 (1978).

10 R.Bonifacio and P.Meystre: "Transient Response in Optical Bistability" Optics Comm. 27, 147 (1978).

11 R.Bonifacio and P.Meystre: "Critical Slowing down in Optical Bisatbility" Optics Comm. 29, 131 51978).

12 Coherence in Spectroscopy and Quantum Optics" Edited by F.T.Arecchi, R. Bonifacio, M.O.Scully (Plenum, New York 1978) cfr. articoli:

"Superconductivity and Quantum Optics" pag. 231 - 259.

"Mean Field Theory of Optical Bistability and Resonance Fluorescence" pag. 85 - 110.

13 R.Bonifacio, M.Milani and M.O.Scully: "Use of a Coherent State formalism in Superconductivity and Josephson-Junction Calculations" Nuovo Cimento B 50, 152 (1979).

14 R.Bonifacio, L.A.Lugiato: "Atomic Cooperation in Quantum Optics": Superfluorescence and Optical Bistability". Proceedings of the Symposium on Synergetics, Schloss Elmau April 30-May 5, 1979, a cura di H.Haken, in corso di stampa - Springer-Verlag (invited paper).

15 R.Bonifacio, L.A.Lugiato e M.Gronchi: "Theory of Optical Bistability" Proceedings of the Fourth Conference on Laser Spectroscopy", Rottach-Egern, June 11-15, 1979 a cura di H.Walher, in corso di stampa - Springer-Verlag (invited paper).

16 R.Bonifacio; M.Gronchi e L.A.Lugiato : "Self-pulsing in Optical Bistability" Optics Comm. 30, 129 (1979).

17 R.Bonifacio, M.Gronchi e L.A.Lugiato: "Dispersive Bistability in Homogeneously Broadened Systems", Nuovo Cimento B 53, 311 (1979).

18 R.Bonifacio, J.D.Farina e L.M.Narducci : "Transverse Effects in Superfluorescence" Optics Comm. 31, 377 (1979).

19 R.Bonifacio, L.A.Lugiato : in "Proc. of Symposium on Synergetics" Schloss-Elmau 1979, a cura di H.Haken, Springer-Verlag 1979.

20 R.Bonifacio, L.A.Lugiato e M.Gronchi : "Laser Spectroscopy IV" a cura di H.Walther e W.K.Rothe. Springer-Verlag 1979.

21 M.Milani, R.Bonifacio e M.Scully : "A Model for Bistability in a Coherently Driven Josephson Junction" Lett. Nuovo Cimento 26, 353 (1979).

22 R.Bonifacio, M.O.Scully : Opt. Comm. 32, 291 (1980)

R.Bonifacio, : Opt. Comm. 32, 440 (1980)

23 R.Bonifacio, P.Meystre, G.T.Moore, M.O.Scully: Phys. Rev.A 21, 2009, (1980).

24 G.Dattoli, A.Renieri, F.Romanelli, R. Bonifacio : Opt. Comm. 34, 240, (1980).

25 R.Bonifacio, F.Casagrande, L.A.Lugiato,: "Exact one-particle theory of a free electron laser" Opt. Comm. (in corso di stampa).

26 R.Bonifacio, F.Casagrande, L.A.Lugiato : "Classical Trajectories and Coherent States of a Free Electron Laser", Proceedings of the Intern. School of Quantum Electronics (ERICE, 1980), ed.S.Martellucci e A. Renieri (Plenum, New York), in corso di stampa.

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Cooperative effects in two-level systems and Free Electron Lasers (FEL)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

We have studied Optical Bistability, Josephson Junctions, Superfluorescence and Free Electron Lasers (FEL) obtaining many original results as described in the final report and in the list of publications. In particular as announced in the last part of our report we have very recently obtained the first theoretical evidence of the possibility of high intensity, chaotic collective spiking behaviour of a FEL for high enough electron density and

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